Densities of large-bodied fish species within the river channel

Expectation:	A statistically significant increase in densities of large-bodied fish species within the restored river channel.
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Relevant Endpoint(s):	Restoration - System Functional Integrity - Habitat Quality

Baseline Conditions:

Channelization of the Kissimmee River altered hydrologic and geomorphic attributes of the river. These alterations, coupled with accompanying physical, chemical, and biological changes, particularly depressed dissolved oxygen levels and reduction in the forage base, have led to decreased densities of large-bodied fishes within remnant river runs. Large-bodied fish species include those in which adults reach lengths (SL) greater than 100 mm.

Post-channelization river channel fish communities were evaluated using block nets and fish toxicant (5% emulsified rotenone). Block nets enclosing 0.2 ha were deployed in three remnant river runs within Pool A (Ice Cream Slough, Rattlesnake Hammock, and Persimmon Mound) and Pool C (MacArthur, Micco Bluff, and Oxbow 13) in June 1997 and May 1998. Results indicate a community comprised of 19 large bodied species (Table 1). Mean annual density of large-bodied fishes collected within pool A was 1141 (± 251) fish/ha. Mean annual density of large-bodied fishes collected within pool C was 1161 (± 324) fish/ha.

Milleson (1976) utilized block nets and fish toxicant to sample a 0.20 ha reach of remnant river run in Pool B following channelization. One hectare of river oxbow contained a standing stock of 1388 individuals of 11 large-bodied species.

Reference Conditions:

Historical data on fish densities in the Kissimmee River ecosystem are limited to a single study (FGFWFC 1957), in which river channel fish were sampled using block nets and 5% emulsified rotenone within a lower reach of the Kissimmee River during drought conditions. One hectare of historic river channel contained a standing crop of 2314 large-bodied fish belonging to 8 species (Table 1). Drought conditions may have affected fish density by concentrating fishes within river channels, or alternatively by leading to downstream migration into Lake Okeechobee.

Mechanism relating restoration:

Increased densities of large-bodied fishes will occur through increased survivorship and recruitment and requires restoration and maintenance of riverine habitats that match the habitat requirements of the historic community (Sheldon & Meffe 1995). Re-establishment of historic hydrologic characteristics will drive the restoration of these characteristics and the river channel fish community.

Restoration of the natural seasonality of discharge regimes and associated connection of the river channel with inundated floodplain habitats is critical for the survival of floodplain dependent river fish species (Welcomme 1979, Copp 1989). Spawning habitat will increase significantly with restoration of historic hydrologic conditions and will include re-inundated floodplain habitats and shallow, sand bottomed littoral margins where accumulated organic deposits will be flushed. Floodplain habitats will provide nursery areas for many river channel species, potentially increasing juvenile survivorship by providing refuge from predators, relief from high instream velocities, and abundant food resources (Guillory 1979, Welcomme 1979, Shaeffer and Nickum 1986, Copp 1989, Junk et al. 1989, Leitman 1991).

Re-introduction of instream flows will flush accumulated organic deposits and provide topographic diversity and a range of flow velocities useful to a larger consort of species and life history stages (Bain et al. 1988, Lobb & Orth 1991, Sheldon & Meffe 1995). Diversity in river channel depth can be positively correlated with fish community attributes including biomass, species richness, density, and mean size (Lobb & Orth 1991, Sheldon & Meffe 1995), with deeper sections having more species, larger individuals, and greater numbers of fishes. Hydrogeomorphic processes also will create snags as riparian vegetation is displaced into the river. Snags provide relief from high velocities, as well as an abundance of prey items (Benke et al. 1985, Lobb & Orth 1991). Re-establishment of riverine food webs will support a higher standing stock of fishes and will occur through increased prey abundance and seasonal import of particulate organic matter and invertebrate and piscine forage from re-connected floodplain habitats (Welcomme 1979, Junk et al. 1989, Sparks 1995).

Restoration of historic discharge rates will increase dissolved oxygen levels due to re-aeration through turbulent mixing and flushing of organic deposits that increase biological oxygen demand in the channelized river (Toth 1993, 1996). Increased dissolved oxygen levels will allow increased survivorship of large-bodied fish species at all life history stages (Cashner et al. 1994, Nurnberg 1995, Brunet & Sabo 1996, Matthews 1998).

Adjustments for External Constraints:

Increased fishing pressure may impact age structure of the community through the removal of larger individuals. Reproductive potential of breeding populations is diminished by the reduction of large individuals from the community, because larger fishes are more fecund than smaller individuals (Lack 1954, Hubbs et al. 1968, Wooten 1984). This can potentially affect densities of year classes.

Time Course:

Increased densities of large-bodied fishes within the restored river system is dependent upon changes in hydrology, geomorphology, and associated biological, physical, and chemical attributes and is expected to occur within 3-5 years following re-establishment of continuous instream flows. Densities may increase immediately following canal backfilling due to displacement of fishes from the canal to river channel. However, displacement of fishes into remnant river channels is not achievement of the expectation. Increased densities must be sustained, which requires restoration of appropriate habitat requirements. Reproduction rates and time periods necessary for fish to reach sexual maturity also are factors. The majority of large bodied species occurring within the Kissimmee River reach sexual maturity between years 2 and 3 (Lee et al. 1980). Restoration time frames may require adjustment if appropriate hydrologic and geomorphologic characteristics are not met.

Means of Evaluation:

Block net sampling will be conducted following 3 years of continuous flows through the restored river channel in Pool C. Methods will be identical to those utilized for baseline studies. Two sampling events will occur during two years of minimal flow within 10 years of reintroduction of continuous flows.

Mean values from the two sampling events will be compared statistically to baseline data. Differences in density will be considered significant if statistical tests result in $P \leq 0.05$. The baseline value used for comparisons of large- bodied fish density within the river channel is 1161 ($\pm$ 324).

Table 1. Large-bodied fish species sampled within the Kissimmee River via block net studies.

Species	Common Name	GFC 1957	Milleson '76	Pool A '97-98	Pool C '97-98
GAME FISH:					
Lepomis gulosus	warmouth	X	X	X	X
Lepomis macrochirus	blugill	X	X	X	X
Lepomis microlophus	redear sunfish	X	X	X	X
Lepomis punctatus	spotted sunfish	--	X	X	X
Micropterus salmoides	largemouth bass	X	X	X	X
Pomoxis nigromaculatus	black crappie	--	X	X	X
Esox americanus	chain pickerel	--	--	X	--
Esox niger	redfin pickerel	--	--	--	X
ROUGH FISH:					
Amia calva	bowfin	--	--	X	X
Erimyzon sucetta	lake chubsucker	X	X	X	X
Dorosoma cepedianum	gizzard shad	--	X	--	X
Lepisosteus osseus	longnose gar	--	--	X	--
Lepisosteus platyrhincus	Florida gar	--	X	X	X
CATFISH:					
Ameiurus catus	white catfish	X	--	--	--
Ameiurus natalis	yellow bullhead	--	--	X	--
Ameiurus nubulosus	brown bullhead	X	X	X	X
Ictalurus punctatus	channel catfish	X	X	--	X
EXOTIC FISH:					
Hoplosternum littorale	armored catfish	--	--	X	X
Oreochromis aureus	blue tilapia	--	--	X	X
Clarias batrachus	walking catfish	--	--	X	X

LITERATURE CITED

Bain, M. B., J. T. Finn and H. E. Brooke. 1988. Streamflow regulation and fish community structure. Ecology. 69(2):382-392.

Benke, A. C., R. L. Henry, III, D. M. Gillepsie and R. J. Hunter. 1985. Importance of snag habitat for animal production in southeastern streams. Fisheries. 10(5):8-13.

Brunet, L. A. and M. J. Sabo. 1996. Effects of hypoxia on ovary development of three *Lepomis* species in Atchafalaya Louisiana. Abstracts ASIH An. Meeting, New Orleans, LA. Pp. 95-96.

Cashner, R. C., F. P. Gelwick, and W. J. Matthews. 1994. Spatial and temporal variation in the distribution of lake fishes of the LaBranche wetlands area of the Lake Ponchartrain Estuary, Louisiana. Northeast Gulf Sci., 13:107-120.

Copp, G. H. 1989. The habitat diversity and fish reproductive function of floodplain ecosystems. Environmental Biology of Fishes. 26:1-27.

Florida Game and Fresh Water Fish Commission. 1957. Recommended program for Kissimmee River Basin. Florida Game and Fresh Water Fish Commission, Tallahasee, Florida.

Guillory, V. 1979. Utilization of an inundated floodplain by Mississippi River Fishes. Florida Scientist. 42(4):222-228.

Hubbs, C., M. M. Stevenson, and A. E. Peden. 1968. Fecundity and egg size in two central Texas darter populations. Southwest. Nat., 81:301-324.

Junk, W. J., P. B. Bayley and R. E. Sparks. 1989. The floodpulse concept in river-floodplain systems. Canadian Special Publication of Fisheries and Aquatic Sciences. 106:110-127.

Lack, D. 1954. The Natural Regulation of Animal Numbers. Claredon Press, Oxford.

Lee, D. S., C. R. Gilbert, C. H. Hocutt, R. E. Jenkins, D. E. McAllister and J. R. Stauffer, Jr. 1980. Atlas of North American Freshwater Fishes. North Carolina State Museum of Natural History Press.

Leitman, H. M., M. R. Darst and J. J. Nordhaus. 1991. Fishes of the forested floodplain of the Ochlockonee River, Florida, during flood and drought conditions. Report 90-4202. U. S. Geological Survey, Tallahassee, Florida.

Lobb, M. D., III and D. J. Orth. 1991. Habitat use by an assemblage of fish in a large warmwater stream.

Trans. Am. Fish. Soc. 120:65-78.

Matthews, W. J. 1998. Patterns in Freshwater Fish Ecology. Chapman and Hall, London.

Milleson, J. F. 1976. Environmental responses to marshland reflooding in the Kissimmee River basin. Tech Pub. 76-3. South Florida Water Management District, West Palm Beach, Florida.

Nurnberg, G.K. 1995. Tha anoxic factor, a quantitative measure of anoxia and fish species richness in central Ontario lakes. Trans. Am. Fish. Soc. 124:677-86.

Scheaffer, W. A., and J. G. Nickum. 1986. Backwater areas as nursery habitats for fishes in pool 13 of the Upper Mississippi River. Hydrobiologia 136:131-140.

Sheldon, A. L. and G. F. Meffe. 1995. Path analysis of collective properties and habitat relationships of fish assemblages in coastal plain streams. Can. J. Fish. Aquatic. Sci. 52:23-33.

Sparks, R. E. 1995. Need for ecosystem management of large rivers and their floodplains. BioScience. 45:168-182.

Toth, L. A. 1993. The ecological basis of the Kissimmee River restoration plan. Florida Scientist. 56(1):25-51.

Toth, L. A. 1996. Restoring the hydrogeomorphology of the channelized Kissimmee River. In: Brookes, A. and F. D. Shields, Jr. River Channel Restoration: Guiding Principles for Sustainable Projects. Pp. 369-383.

Welcomme, R. L. 1979. Fisheries ecology of floodplain rivers. Longman Group Limited. London, England.

Wooten, R.J. 1984. Introduction: tactics and strategies in fish reproduction., *In* , Fish Reproduction: Strategies and Tactics, (G. W. Potts and R. J. Wooten, eds.). Academic Press, London.